



Limited Visual Dam Safety Inspection Summary Report

MA-071

Reservoir 21

Maui, Hawaii

Prepared by:

**U.S. ARMY CORPS OF ENGINEERS
HONOLULU ENGINEER DISTRICT**

**STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES**

May 2006

Dam ID: MA-071

Name: Reservoir 21

Limited Visual Dam Safety Inspection Conducted on: 05 April 2006

I. Purpose:

Due to disaster occurrences of periodic heavy rains and flooding, which has caused extensive damage to property and loss of lives, the Governor has issued a State of Emergency Proclamation extending from February 20, 2006 to April 9, 2006. In light of the tragic failure of the Kaloko dam on Kauai and the continued forecast of heavy rains, emergency inspections of all regulated dams in all counties are being undertaken.

These inspections are for the purpose of determining if any of the regulated dams and reservoirs in the City and County of Honolulu, Maui County or Hawaii County, are suspect for immediate concern to the downstream area under the prolonged conditions of heavy rain showers.

II. Authority

Inspections are authorized under the Hawaii Dam Safety Act of 1987, Chapter 179D "Dams and Reservoirs" of Hawaii Revised Statutes, and Title 13, Subtitle 7, Chapter 190, "Dams and Reservoirs" of the Hawaii Administrative Rules.

These inspections are being conducted under joint agreements of the U.S. Army Corps of Engineers (USACE), the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS), and the State of Hawaii. The Memorandum of Agreement with the U.S. Army Corps of Engineers is entered into pursuant to 10 U.S.C. § 3036(d)(2), and the Intergovernmental Cooperation Act (31 U.S.C. §6505), and established via support agreement number DL-06-01.

III. Scope

Visual inspection will be made on parts of the embankment and appurtenant works readily available and visible for inspection by the inspection team at the time of the inspection. Such parts and appurtenant works would include the upstream slope, crest, downstream slope, abutments and toes, outlet works, and spillway.

On the date of this limited visual inspection, there may appear to be no immediate threat to the safety of the dam, however no assurance can be made regarding the dam's condition after this date. Subsequent adverse weather and other factors may affect the dam's condition.

IV. Limitations of Findings and Recommendations

The inspection is based only on visible features/areas of the dam on the day of inspection. The inspection does not entail detailed stability, hydrologic, hydraulic, or seismic investigations. This inspection is not a formal phase I or phase II dam safety inspection and does not include a review or evaluation from each specialist of an inspection team, such as a geologists, civil, geotechnical, structural, or hydraulics engineer. The owner should verify the findings of this report and take corrective actions. The owner may submit to the State alternative corrective actions that are certified by a licensed professional engineer in the State of Hawaii experienced in the design and construction of dams. This inspection does not relieve the owner/operator from their responsibility to conduct routine inspections, maintenance, repairs, modifications, monitoring, documentation, and/or investigative studies.

V. Inspection Team

<u>Organization</u>	<u>Name /Title</u>
U.S. Army Corps of Engineers	Jon Kolber Geotechnical Engineer
State of Hawaii, Dept. of Land and Natural Resources	Eric Yuasa Civil Engineer
USDA, Natural Resource Conservation Service	Diana Perry
USDA, Natural Resource Conservation Service	Michael Hayama Civil Engineer

VI. Owner's Representatives Present

Hawaiian Commercial and Sugar Company.	Randall Moore
East Maui Irrigation Company	Garrett Hew

VII. Inspection Team

<u>Organization</u>	<u>Name</u>
U.S. Army Corps of Engineers	Derek Chow Bill Empson
State of Hawaii, Dept. of Land and Natural Resources	Denise Manuel Edwin Matsuda

VIII. Dam Type

The dam appeared to be an earthen embankment dam.

IX. Dam Classification

The current hazard classification of this dam is: High

Hazard Potential Classification based on the following:

Category	Loss of Life	Economic Loss
Low	None Expected	Minimal (undeveloped to occasional structures or agriculture)
Significant	Few (No Urban development and no more than a small number of inhabitable structures)	Appreciable (Notable agriculture, industry or structures)
High	More than a few	Extensive community, industry or agriculture.

Based on inventoried storage and height data, the size classification of the dam is: Most likely Small.

Size Classification based on the following:

Category	Storage (Acre-Feet)	Height (feet)
Small	< 1000	< 40
Intermediate	> 1000 and < 50,000	> 40 and < 100
Large	> 50,000	> 100

X. Summary of Inspection

Condition Rating Criteria: The conditional terms in this report are used to generally describe the conditions below. Inspections, monitoring, and additional investigations are considered to be incidental to all condition ratings.

Satisfactory	Expected to fulfill intended function.
Fair	Expected to fulfill intended function, but maintenance is recommended.
Poor	May not fulfill intended function; maintenance or repairs are necessary.
Unsatisfactory	Is not expected to fulfill intended function; repair, replacement, or modification is necessary.
Unknown	Not visible, not accessible, not inspected, or unable to determine the condition rating based on the observation taken.

A. General appearance:

This reservoir was completed in 1913 and continues to operate as an irrigation control structure. The dam is 25 feet high and 950 feet long. The reservoir appears to have a significant drainage area.

Findings and Corrective Actions:

- a. The Owner shall maintain documentations including Construction plans, specifications, improvements, modifications, Operations and Maintenance Manuals and routine inspection logs for this dam facility.
- b. An EAP is required for High Hazard Dams. Submit an updated EAP for this facility.
- c. Routine inspection logs were not inspected.
- d. Dam owners shall provide for routine inspection of the dam.
- e. Access to site appears to be satisfactory.
- f. Submit current Operations and Maintenance Manual or Procedures for this dam / reservoir facility.
- g. Submit Site or Facility Map of this Dam which identifies the location of major features including outlet works controls and conduits.
- h. Emergency Alarms / Monitors: There were no alarms or monitors observed on this reservoir.
- i. Power / Communication: There were no communication systems observed on this reservoir.

B. Access / Security:

Access to the dam was accomplished via access roads. A four-wheel drive vehicle is required.

Security issues. Access to the dam is unrestricted.

C. Intake Works: (Satisfactory)

Water flows into the reservoir through an irrigation ditch approximately 10 feet by 5 feet. The intake is controlled by a gate.

Findings and Corrective Actions:

- a. The intake works were not tested.
- b. The intake works appeared to be in satisfactory condition. No corrective actions are required at this time.

D. Reservoir: (Satisfactory)

The reservoir was 16 feet per gage at the time of inspection. The normal operating level is 10 to 17 feet per gage. A PVC staff gage was observed in the middle of the reservoir.

Findings and Corrective Actions:

- a. The reservoir appeared to be in satisfactory condition, no corrective actions are required at this time.

E. Upstream Slope: (Fair)

The upstream slope is on an approximate 2 on 1 slope. The slope is overgrown by tall vegetation, including many trees.

Findings and Corrective Actions:

- a. The upstream slope appeared to be in fair to poor condition and requires corrective action.
- b. Slope protection needs maintenance. Description: Need to remove trees and other vegetation from the upstream slope.
- c. The upstream slope was not visible due to high grass and bush vegetation. Clear high vegetation and maintain low to enable easy visual inspection.
- d. Trees were observed on the dam embankment. Trees have been identified as the probable cause of piping failures and can possibly cause severe damage to the embankment if they are uprooted during high winds. Corrective action is required to remove tree hazards from the dam. Acceptable remedies include removal of the tree and its root structure down to a 2-inch diameter and reconstructing the damaged embankment section. All repair work shall be accomplished as per the requirements of licensed geotechnical or structural engineers. Routinely monitor the damaged area for signs of settlement and seepage.

F. Crest: (Fair)

The dam crest was approximately 10 feet wide. It was overgrown with tall vegetation, including many small trees.

Findings and Corrective Actions:

- a. The dam crest appeared to be in fair to poor condition and requires corrective action.
- b. Portions of the crest were not visible due to high grass and bush vegetation. Clear high vegetation and maintain low to enable easy visual inspection.
- c. Trees were observed along the dam crest. Trees have been identified as the probable cause of piping failures and can possibly cause severe damage to the embankment if they are uprooted during high winds. Corrective action is required to remove the tree hazards from the dam. Acceptable remedies include removal of the tree and its root structure down to a 2-inch diameter and reconstructing the damaged embankment section. All repair work shall be accomplished as per the requirements of a licensed geotechnical or structural

engineer. Routinely monitor the damaged area for signs of settlement and seepage.

G. Downstream Slope: (Fair)

The downstream slope was approximately 1 on 1. Trees and tall grass were growing on the downstream slope, obscuring it from visual inspection.

Findings and Corrective Actions:

- a. The downstream slope appeared to be in fair to poor condition and requires action.
- b. Slope protection needs maintenance. Need to remove trees and other vegetation from the downstream slope.
- c. The downstream slope was not visible due to high grass and bush vegetation. Clear high vegetation and maintain low to enable easy inspection.
- d. Trees were observed on the downstream slope. Trees have been identified as the probable cause of piping failures and can possibly cause severe damage to the embankment if they are uprooted during high winds. Corrective action is required to remove tree hazards from the dam. Acceptable remedies include removal of the tree and its root structure down to a 2-inch diameter and reconstructing the damaged embankment section. All repair work shall be accomplished as per the requirements of a licensed geotechnical or structural engineer. Routinely monitor the damaged area for signs of settlement and seepage.

H. Abutments / Toe: (Fair)

The abutments/toe were obscured by trees and other tall vegetation.

Findings and Corrective Actions:

- a. The abutments/toe appeared to be in fair to poor condition and requires corrective action.
- b. The slope protection needs maintenance by removing trees and other tall growth from the abutments.
- c. The abutment area was not visible due to tall vegetation. Clear high vegetation to enable easy visual inspection.
- d. Trees were observed along the abutments. Trees have been identified as the probable cause of piping failures and can possibly cause severe damage to the embankment if they are uprooted during high winds. Corrective action is required to remove the tree hazards from the dam. Acceptable remedies include removal of the tree and its root structure down to a 2-inch diameter and reconstructing the damaged embankment section. All repair work shall be accomplished as per the requirements of a licensed geotechnical or structural engineer. Routinely monitor the damaged area for signs of settlement and seepage.

I. Outlet Works: (Satisfactory)

The outlet works consist of a 12-inch diameter DIP pipe controlled on the downstream side of the dam by a valve.

Findings and Corrective Actions:

- a. The outlet works were not tested.
- b. The outlet works appear to be in satisfactory condition. No corrective actions are required at this time.

J. Spillway: (Satisfactory)

This spillway is concrete weir, approximately 20 feet by 30 feet, which flows into a concrete lined ditch.

Findings and Corrective Actions:

- a. The Spillway appeared to be in satisfactory condition, no corrective actions are required at this time.

K. Down Stream Channel: (Unknown)

There is an undefined downstream drainage-way downstream of the dam.

Findings and Corrective Actions:

- a. The downstream channel was not inspected.

XI. Additional Comments:

Based on visual observations and discussion of operational procedures of the day, there is no immediate threat to the safety of the dam at this time.

Reservoir is fed from the Kauhikoa ditch (controlled by a wooden gate). Outlet works feeds irrigation ditch and/or drip irrigation system. Concrete spillway discharges into a concrete lined ditch that runs along the downstream slope toe.

PHOTOGRAPHS

MA-071 Maui Reservoir 21

MA-071 Maui Reservoir 21



071 Crest - Note the tall grass and the trees on the left at the edge of the crest.

MA-071 Maui Reservoir 21



071 Crest 2 - Note the overgrown vegetation which completely obscures the crest.

MA-071 Maui Reservoir 21



071 Downslope - Note the overgrown vegetation which obscures the downstream slope.

MA-071 Maui Reservoir 21



071 In channel - View of the irrigation ditch which flows into the reservoir

MA-071 Maui Reservoir 21



071 In valve - View of the inlet and control valve to the reservoir

MA-071 Maui Reservoir 21



071 Inlet - View of the inlet channel to the reservoir, looking downstream towards the reservoir

MA-071 Maui Reservoir 21



071 Panoramic view of the reservoir, looking downstream at the upper slope

MA-071 Maui Reservoir 21



071 Panoramic view of the reservoir, looking downstream at the upper slope

MA-071 Maui Reservoir 21



071 Panoramic view of the reservoir, looking downstream at the upper slope

MA-071 Maui Reservoir 21



071 Panoramic view of the reservoir, looking downstream at the upper slope

MA-071 Maui Reservoir 21



071 Spillway

FIELD INSPECTION SHEETS

Dam ID: MA-0071RESERVOIR 21**Vulnerability Index:**

Extreme	High	Moderate	Low
1	2	3	4

Inspection No: _____

Date: 4/05/2006

STATE OF HAWAII - DLNR
DAM SAFETY INSPECTION SHEET

Inspection Type: Visual Dam Safety Inspection**Persons Present****Affiliation****Phone Number**

Jon Kolben
Diana Perry
Eric Yvora
Michael Hayama
Randall Moore
Corey Adler
Garrett Hew

US Army Corps of Engineers
USDA/NRCS
Hawaii DLNR
USDA/NRCS
Hawaii Commercial Sugar Co.
Hawaii DLNR / Forestry
Hawaii Commercial Sugar Co.
(CEMI)

Weather Condition: ☐ Rain previous day ☐ Rainy ☐ Drizzle / Mist ☐ Cloudy/Overcast ☐ Partly Cloudy ☒ Sunny ☐ Dry

Comments: _____

1. General: (Information currently on file, update as required)

Dam/Res. Name	<u>RESERVOIR 21</u>		
Owner	<u>Hawaiian Commercial & Sugar Company, a division of Alexander & Baldwin, Inc. (C010)</u>		
Owner Contact	<u>Mr. Randall Moore</u>	Owner Ph.	_____
Lessee	<u>N/A</u>	Lessee Ph.	_____
O & M Contractor	<u>HC&S</u>	O & M Ph.	_____
Nearest Town	<u>UPPER PAIA</u>	Latitude	<u>20.8917 ° (decimal)</u>
County	<u>MAUI</u>	Longitude	<u>156.345 ° (decimal)</u>
Tax Map Key(s)	<u>(2)2-5-004:039</u>		

Dam Status	<u>A:</u>	Hazard Potential	<u>H:</u>	Dam Size	_____
Year Completed	<u>1913</u>	Dam Length	<u>950</u> ft.	Dam Height	<u>25</u> ft.
Normal Storage	<u>57</u> ac.ft.	Max. Storage	<u>72</u> ac.ft.	Max. Surface Area	<u>6.9</u> ac.
Drainage Area	_____ mi.	Spillway Type	_____	Max. Spillway Q	_____ cfs

Owner owns land under dam facility: _____

Emergency Action Plan on file with the Department: NOReports on file with the Department: May 1980 = Army Corps of Engineers, Initial Dam Safety Inspection / Survey (2)

2. Questions for Owner's Rep.:

	Yes	No	Unknown	Comments
Construction Plans Available	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
Site / Facility Map	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
Operation & Maintenance Manual	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Emergency Action Plan	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Modifications / Improvements	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Conduct Routine Inspections	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Conduct Routine Maintenance	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Vehicle access to site	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> Not accessible <input type="checkbox"/> With Standard car <input checked="" type="checkbox"/> Requires 4-Wheel Drive
Access during heavy rains	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> Not accessible <input type="checkbox"/> With Standard car <input checked="" type="checkbox"/> Requires 4-Wheel Drive
Access when spillway is flowing	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> Not accessible <input type="checkbox"/> With Standard car <input checked="" type="checkbox"/> Requires 4-Wheel Drive
Other Studies Conducted	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/> Phase I <input type="checkbox"/> Phase II <input type="checkbox"/> Hydraulics <input type="checkbox"/> Stability <input type="checkbox"/> Hazard <input type="checkbox"/> Seismic <input type="checkbox"/> Other: _____
Incident History	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> Breached <input type="checkbox"/> Overtop <input type="checkbox"/> Slide <input type="checkbox"/> Down stream Flooding <input type="checkbox"/> Other: _____
Reservoir's Current Use	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> Sediment <input checked="" type="checkbox"/> Irrigation <input type="checkbox"/> Recreation <input type="checkbox"/> Flood Control <input type="checkbox"/> Drinking Water <input type="checkbox"/> Power Generation <input type="checkbox"/> Other: _____

Findings and Corrective Actions:

- ☒ a. The Owner shall maintain documentations including Construction plans, specifications, improvements, modifications, Operations and Maintenance Manuals and routine inspection logs for this dam facility.
- ☐ b. An Emergency Action Plan (EAP) is on file with the department, submit any updates as applicable.
- ☒ c. An EAP is required for High Hazard Dams. Submit an updated EAP for this facility.
- ☐ d. An EAP is recommended for all dams regardless of hazard class. Submit EAP if developed for the facility.
- ☐ e. Submit narrative and additional information detailing the improvements, modifications, and/or alterations at the dam site, unless covered by approved dam permit.
- ☒ f. Routine inspection logs were not inspected.
- ☒ g. Dam owners shall provide for routine inspection of the dam.
- ☐ h. The dam did not appear to be maintained on a regular basis.
- ☒ i. Access to site appears to be satisfactory.
- ☐ j. There is no vehicular access to the dam site. Operational and emergency plans need to reflect this deficiency or access provided.
- ☐ k. Access to dam is questionable during severe weather conditions and/or spillway overflows. Operational plans and emergency plans need to reflect this deficiency or access provided.
- ☐ l. Provide a detailed narrative of the incident, responses taken, and any damages incurred. Dam owners are required to promptly advise the department of any sudden or unprecedented flood or unusual or alarming circumstance or occurrences which may adversely affect the dam or reservoir.
- ☒ m. Submit current Operations and Maintenance Manual or Procedures for this dam / reservoir facility.
- ☒ n. Submit Site or Facility Map of this Dam which identifies the location of major features including outlet works controls and conduits.
- ☐ o. _____

Additional Requirements:

The following investigative study(s) are:

Required Recommended

- | | | |
|--------------------------|--------------------------|----------------------------------------------------------------------------------------------------------------------------------------|
| <input type="checkbox"/> | | Phase I Study |
| <input type="checkbox"/> | <input type="checkbox"/> | Phase II Study (Including <input type="checkbox"/> Seepage <input type="checkbox"/> Hydrology/Hydraulics <input type="checkbox"/> EAP) |
| <input type="checkbox"/> | <input type="checkbox"/> | Hydrology and Hydraulics (including Probable Maximum Flood and spillway capacity) |
| <input type="checkbox"/> | <input type="checkbox"/> | Stability Analysis |
| <input type="checkbox"/> | <input type="checkbox"/> | Seismic Analysis |
| <input type="checkbox"/> | <input type="checkbox"/> | Hazard Classification |
| <input type="checkbox"/> | <input type="checkbox"/> | Other: _____ |

Dam ID: MA-0071

RESERVOIR 21

Inspection No: _____

Date: 4/05/2006

Physical Dam Features: (Check All Applicable. Provide description of Items Observed and/or Take Photos. Indicate photo # in description.)**3. Reservoir:**Level during inspection 16 ft per (gage) / other)Normal Operating Level/Range 10' ft per 17' (gage / other)

Description: _____

Typical Operation ☐ Spillway always flowing ☒ Kept within normal range ☐ Kept Empty ☐ Drained Daily ☐ Only filled by Storms
☐ Other: _____Sinkhole in Res.: ☐ # Observed: _____ Size: _____ by _____ in. Deep ☒ Not Visible ☒ None Observed

Description: _____

Staff Gage: Description: PVC River Piped**Findings:**

- ☐ a. The reservoir was not inspected.
- ☒ b. The reservoir appeared to be in satisfactory condition, no corrective actions are required at this time.
- ☐ c. The reservoir appeared to be in fair to poor condition and requires corrective action.
- ☐ d. The reservoir appeared to be in unsatisfactory condition, urgent corrective action is required.

Corrective Actions:

- ☐ e. The staff gage needs maintenance and/or repair. Description: _____
- ☐ f. A staff gage was not observed at the reservoir. Provide some method of quantifying the water level within the reservoir.
- ☐ g. A sinkhole was observed in the upstream reservoir. Conduct additional investigations and monitoring to identify the cause, risk and appropriate action.
- ☐ h. _____

4. Intake Works Description:☒ Number of Intakes 1

Intake Culvert / Pipe

Size: _____ in. ☐ DIP ☐ Corrugated Metal ☐ PVC ☐ HDPE ☐ Concrete ☐ Other _____Control: ☐ Gate ☐ Valve ☐ Flow can either be Shut off or BypassedFrom: ☐ Stream Diversion ☐ Pump ☐ Reservoir ☐ Other _____☒ Ditch / Flume

Dimension: _____ (Size x Depth) Shape _____

Surface: ☐ Dirt ☒ Wood ☐ Concrete ☐ Lined w/ _____Control: ☒ Gate ☐ Valve ☐ Flow can either be Shut off or BypassedFrom: ☐ Stream Diversion ☐ Pump ☐ Reservoir ☒ Other Ditch 10' x 5'**Findings:**

- ☐ a. The intake works were not inspected.
- ☒ b. The intake works were not tested.
- ☒ c. The intake works appeared to be in satisfactory condition, no corrective actions are required at this time.
- ☐ d. The intake works appeared to be in fair to poor condition and requires corrective action.
- ☐ e. The intake works appeared to be in unsatisfactory condition, urgent corrective action is required.

Corrective Actions:

- ☐ f. The intake works needs maintenance and/or repair. Description: _____
- ☐ g. _____

Dam ID: MA-0071

RESERVOIR 21

Inspection No: _____

Date: 4/25/2006

5. Upstream Slope:

(Typical Slope \pm 2H: 1V)

Slope Protection: ☐ None ☐ Dumped Rock ☒ Fitted Rip Rap ☐ Grouted Rip Rap ☐ Liner _____ ☐ Other: _____

☐ Defect in Protection: Description: _____

Erosion: ☐ Loose soil w/ little vegetation ☐ Rut (<6") ☐ Gully (>6" deep) ☒ Not Visible ☐ None Observed

Description: _____

Cracks: ☐ Parallel with crest ☐ Perpendicular to crest ☐ Slide visible ☒ Not Visible ☐ None Observed

Description: _____

Sinkholes: ☐ # Observed: _____ Size: _____ and _____ Depth ☒ Not Visible ☐ None Observed

Description: _____

Vegetation: ☐ None ☐ Low Ground Cover ☒ Bushes or Tall Grass ☒ Trees # MANY ☒ <6" ☐ >6" & <20" ☐ >20"

Description: _____

Findings:

- ☐ a. The upstream slope was not inspected.
- ☐ b. The upstream slope appeared to be in satisfactory condition, no corrective actions are required at this time.
- ☒ c. The upstream slope appeared to be in fair to poor condition and requires corrective action.
- ☐ d. The upstream slope appeared to be in unsatisfactory condition and not expected to fulfill its intended function. Urgent corrective action is required.

Corrective Actions:

- ☒ e. Slope protection needs maintenance or repair. Description: Remove Tall Grass
- ☐ f. Rut and/or Gully erosion was observed on the slope, which requires maintenance and/or repair. Description: _____
- ☐ g. A crack was observed on the slope, which requires further investigation to determine the underlining cause. Monitor the area and/or repair as required.
- ☐ h. A sinkhole was observed on the slope, which requires further investigation to determine the underlining cause. Repair and monitor the area.
- ☒ i. The upstream slope was not visible due to high grass and bush vegetation. Clear high vegetation and maintain low to enable easy visual inspection.
- ☒ j. Tree(s) were observed on the dam embankment. Trees have been identified as the probably cause of piping failures, and can possibly cause sever damage to the embankment if they are uprooted during a high winds. Corrective action is required to remove the tree hazards from the dam. Acceptable remedies include removal of the tree and its root structure down to a 2" diameter and reconstructing the damaged embankment section. All repair work shall be accomplished as per the requirements of licensed geotechnical or structural engineer. Routinely monitor the damaged area for signs of settlement and seepage.
- ☐ k. _____

Dam ID: MA-0071

RESERVOIR 21

Inspection No:

Date: 4/05/2006

6. Crest:

Approximate Crest Width: 10'

Access: ☐ None ☐ Walking Path ☐ Roadway, Surface / Width / Usage:

Erosion: ☐ Loose soil w/ little vegetation ☐ Rut (<6") ☐ Gully (>6" deep) ☒ Not Visible ☐ None Observed

Description:

Cracks: ☐ Parallel with crest ☐ Perpendicular to crest ☐ Slide visible ☒ Not Visible ☐ None Observed

Description:

Sinkholes: ☐ _____ in. Wide x _____ in. Long x _____ in. Deep ☒ Not Visible ☐ None Observed

Description:

Vegetation: ☐ None ☐ Low Ground Cover ☒ Bushes or Tall Grass ☒ Trees # Many ☒ <6" ☐ >6" & <20" ☐ >20"

Description:

Findings:

- ☐ a. The dam crest was not inspected.
- ☐ b. The dam crest appeared to be in satisfactory condition, no corrective actions are required at this time.
- ☒ c. The dam crest appeared to be in fair to poor condition and requires corrective action.
- ☐ d. The dam crest appeared to be in unsatisfactory condition and not expected to fulfill its intended function. Urgent corrective action is required.

Corrective Actions:

- ☐ e. Access along the crest was satisfactory.
- ☐ f. Access along the crest was not possible. Description:
- ☐ g. Rut and/or Gully erosion was observed on the crest, which requires maintenance and/or repair. Description:
- ☐ h. A crack was observed on the crest, which requires further investigation to determine the underlining cause. Monitor the area and/or repair as required.
- ☐ i. A sinkhole was observed on the crest, which requires further investigation to determine the underlining cause. Repair and monitor the area.
- ☒ j. Portions of the crest were not visible due to high grass and bush vegetation. Clear high vegetation and maintain low to enable easy visual inspection.
- ☒ k. Tree(s) were observed along the dam crest. Trees have been identified as the probably cause of piping failures, and can possibly cause sever damage to the embankment if they are uprooted during a high winds. Corrective action is required to remove the tree hazards from the dam. Acceptable remedies include removal of the tree and its root structure down to a 2" diameter and reconstructing the damaged embankment section. All repair work shall be accomplished as per the requirements of licensed geotechnical or structural engineer. Routinely monitor the damaged area for signs of settlement and seepage.
- ☒ l. Remove Trees & Tall Vegetation Along Crest

7. Downstream Slope:

(Typical Slope \pm 1 : 1)Access: ☒ lower roadway along toe ☐ roadway to outlet works ☐ walkway to outlet works ☐ None ObservedSlope Protection: ☒ None ☐ Dumped Rock ☐ Rip Rap ☐ Grouted Rip Rap ☐ ConcreteErosion: ☐ Loose soil w/ little vegetation ☐ Rut (<6") ☐ Gully (>6" deep) ☒ Not Visible ☐ None Observed

Description: _____

Cracks: ☐ Parallel with crest ☐ Perpendicular to crest ☐ Slide visible ☒ Not Visible ☐ None Observed

Description: _____

Sinkholes: ☐ _____ in. Wide x _____ in. Long x _____ in. Deep ☒ Not Visible ☐ None Observed

Description: _____

Vegetation: ☐ None ☐ Low Ground Cover ☒ Bushes or Tall Grass ☒ Trees # Many ☐ <6" ☐ >6" & <20" ☒ >20"

Description: Overgrown

Seepage: Seep Spot Number 1

☐ Green Vegetation ☐ Wet or Muddy Ground ☐ Ponding Water ☒ Not Visible ☐ None Observed

Flowing, Description: _____

Water Clarity: ☐ Clear ☐ Some particles ☐ Muddy ☐ Other: _____

Description: _____

Seep Spot Number 2

☐ Green Vegetation ☐ Wet or Muddy Ground ☐ Ponding Water ☐ Not Visible ☐ None Observed

Flowing, Description: _____

Water Clarity: ☐ Clear ☐ Some particles ☐ Muddy ☐ Other: _____

Description: _____

Findings:

- ☐ a. The downstream slope was not inspected.
- ☐ b. The downstream slope appeared to be in satisfactory condition, no corrective actions are required at this time.
- ☒ c. The downstream slope appeared to be in fair to poor condition and requires corrective action.
- ☐ d. The downstream slope appeared to be in unsatisfactory condition and not expected to fulfill its intended function. Urgent corrective action is required.

Corrective Actions:

- ☒ e. Slope protection needs maintenance or repair. Description: Remove Tree, & Tail
- ☐ f. Rut and/or Gully erosion was observed on the slope, which requires maintenance and/or repair. Description: Vegetation
- ☐ g. A crack was observed on the slope, which requires further investigation to determine the underlining cause. Monitor the area and/or repair as required.
- ☐ h. A sinkhole was observed on the slope, which requires further investigation to determine the underlining cause. Repair and monitor the area.
- ☒ i. The down stream slope was not visible due to high grass and bush vegetation. Clear high vegetation and maintain low to enable easy visual inspection.
- ☒ j. Tree(s) were observed on the downstream slope. Trees have been identified as the probably cause of piping failures, and can possibly cause sever damage to the embankment if they are uprooted during a high winds. Corrective action is required to remove the tree hazards from the dam. Acceptable remedies include removal of the tree and its root structure down to a 2" diameter and reconstructing the damaged embankment section. All repair work shall be accomplished as per the requirements of licensed geotechnical or structural engineer. Routinely monitor the damaged area for signs of settlement and seepage.
- ☐ k. Seepage/Ponding water was observed. Monitor and conduct further investigation to locate the source of water and extent of any possible hazardous or developing condition.
- ☐ l. Seepage was observed flowing and particles were observed to be removed by the flow. Take immediate action to stop the loss of soil from the embankment. Conduct further investigation to determine the underlining cause and take corrective action. Monitor the area.
- ☐ m. The slope was very steep, around a 1 to 1 slope, further study is required to verify slope stability.
- ☐ n. _____

8. Abutments/Toe:

Erosion: ☐ Loose soil w/ little vegetation ☐ Rut (<6") ☐ Gully (>6" deep) ☒ Not Visible ☐ None Observed
 Description: _____

Cracks: ☐ Parallel with crest ☐ Perpendicular to crest ☐ Slide visible ☒ Not Visible ☐ None Observed
 Description: _____

Vegetation: ☐ None ☐ Low Ground Cover ☒ Bushes or Tall Grass ☐ Trees # Many ☐ <6" ☐ >6" & <20" ☒ >20"
 Description: _____

Seepage: Seep Spot Number 1
☐ Green Vegetation ☐ Wet or Muddy Ground ☐ Ponding Water ☒ Not Visible ☐ None Observed
☐ Flowing, Description: _____
 Water Clarity: ☐ Clear ☐ Some particles ☐ Muddy ☐ Other: _____
 Description: _____

Seep Spot Number 2
☐ Green Vegetation ☐ Wet or Muddy Ground ☐ Ponding Water ☐ Not Visible ☐ None Observed
☐ Flowing, Description: _____
 Water Clarity: ☐ Clear ☐ Some particles ☐ Muddy ☐ Other: _____
 Description: _____

Findings:

- ☐ a. The abutments/toe were not inspected.
- ☐ b. The abutments/toe appeared to be in satisfactory condition, no corrective actions are required at this time.
- ☒ c. The abutments/toe appeared to be in fair to poor condition and requires corrective action.
- ☐ d. The abutments/toe appeared to be in unsatisfactory condition and not expected to fulfill its intended function. Urgent corrective action is required.

Corrective Actions:

- ☒ e. Slope protection needs maintenance or repair. Description: Remove Trees & Tall
- ☐ f. Rut and/or Gully erosion was observed, which requires maintenance and/or repair. Vegetation
 Description: _____
- ☐ g. A crack was observed along the abutments/near the toe, which requires further investigation to determine the underlining cause. Monitor the area and/or repair as required.
- ☒ h. The abutment/toe area was not visible due to high grass and bush vegetation. Clear high vegetation and maintain low to enable easy visual inspection.
- ☒ i. Tree(s) were observed along the abutment/toe. Trees have been identified as the probably cause of piping failures, and can possibly cause sever damage to the embankment if they are uprooted during a high winds. Corrective action is required to remove the tree hazards from the dam. Acceptable remedies include removal of the tree and its root structure down to a 2" diameter and reconstructing the damaged embankment section. All repair work shall be accomplished as per the requirements of licensed geotechnical or structural engineer. Routinely monitor the damaged area for signs of settlement and seepage.
- ☐ j. Seepage/Ponding water was observed. Monitor and conduct further investigation to locate the source of water and extent of any possible hazardous or developing condition.
- ☐ k. Seepage was observed flowing and particles were observed to be removed by the flow. Take immediate action to stop the loss of soil from the embankment. Conduct further investigation to determine the underlining cause and take corrective action. Monitor the area.
- ☐ l. _____

9. Outlet Works:

Culvert / Pipe

Type / Size:

12" Valved

Culvert:

☐ Concrete☐ Masonry☐ unlined earth☐ Other _____

Pipe:

☒ DIP☐ Corrugated Metal☐ PVC☐ HDPE☐ Concrete☐ Other _____

Control Type:

☐ Gate☒ Valve☐ Other _____

Location:

☐ Control on Upstream side☒ Control on Downstream side

Seepage:

☐ Green Vegetation☐ Wet or Muddy Ground☐ Ponding Water☐ Not Visible☒ None Observed

Flowing, Description: _____

Water Clarity: ☐ Clear☐ Some particles☐ Muddy☐ Other: _____

Description: _____

Findings:

- ☐ a. The outlet works were not inspected.
- ☒ b. The outlet works were not tested.
- ☒ c. The outlet works appeared to be in satisfactory condition, no corrective actions are required at this time.
- ☐ d. The outlet works appeared to be in fair to poor condition and requires corrective action.
- ☐ e. The outlet works appeared to be in unsatisfactory condition and not expected to fulfill its intended function. Urgent corrective action is required.

Corrective Actions:

- ☐ f. Seepage/Ponding water was observed. Conduct further investigation to locate the source of water and extent of any possible hazardous or developing condition.
- ☐ g. Seepage was observed flowing and particles were observed to be removed by the flow. Take immediate action to stop the loss of soil. Conduct further investigation to determine the underlining cause and take corrective action. Monitor the area. Failures caused by seepage/piping along the outlet conduit are very common and are considered to be a dangerous situation.
- ☐ h. Were not visible due to high grass and bush vegetation. Clear high vegetation and maintain low to enable easy visual inspection.
- ☐ i. _____
- ☐ j. _____

10. Spillway:

Type:

☐ None ☐ Culvert/Pipe ☒ Channel

Description:

Concrete

Dimension:

20' x 30'

ft.

Invert elevation:

ft.

per staff gage

Slope Protection:

☐ None ☐ Grass ☐ Dumped Rock ☐ Fitted Rip Rap ☐ Grouted Rip Rap☒ Concrete☐ Defect in Protection: Description: _____

Approach:

☒ Clear ☐ High Veg. ☐ Trees

Erosion:

☐ Scour ☐ Gully ☐ Headcut ☒ Not Observed☐ Other: _____

Description: _____

Vegetation:

☒ None ☐ Low Ground Cover ☐ Bushes or Tall Grass ☐ Trees # _____ ☐ <6" ☐ >6" & <20" ☐ >20"

Description: _____

Findings:

- ☒ a. The Spillway appeared to be in satisfactory condition, no corrective actions are required at this time.
- ☐ b. The Spillway appeared to be in fair to poor condition and requires corrective action.
- ☐ c. The Spillway appeared to be in unsatisfactory condition and not expected to fulfill its intended function. Urgent corrective action is required.

Corrective Actions:

- ☐ d. Slope protection needs maintenance or repair. Description: _____
- ☐ e. The spillway approach was blocked. Clear approach.
- ☐ f. Severe scour erosion was observed which requires maintenance and/or repair.
Description: _____
- ☐ g. A headcut (vertical drop in channel due to erosion) was observed downstream of the spillway. Corrective action is required to prevent this problem from moving upstream.
- ☐ h. Trees are unacceptable in the spillway channel and approach. Take corrective action to address the woody vegetation problem and repair the damaged area.
- ☐ i. Unclear if spillway is adequately sized. Spillway should pass the probable maximum flood. Verify spillway capacity and take corrective action as required.
- ☐ j. _____

11. Down Stream Channel:

Name: _____

Downstream:

☐ Sump ☐ Open Area ☒ Un-Defined Drainage-way ☐ Defined Drainage-way ☐ Other _____

Items along Stream Bank:

☒ None ☐ Road ☐ Houses ☐ Town ☐ Not Inspected

Description: _____

Findings:

- ☒ a. The downstream channel was not inspected.
- ☐ b. The downstream channel appeared to be in satisfactory condition, no corrective actions are required at this time.
- ☐ c. The downstream channel appeared to be in fair to poor condition and requires corrective action.
- ☐ d. The downstream channel appeared to be in unsatisfactory condition and not expected to fulfill its intended function. Urgent corrective action is required.

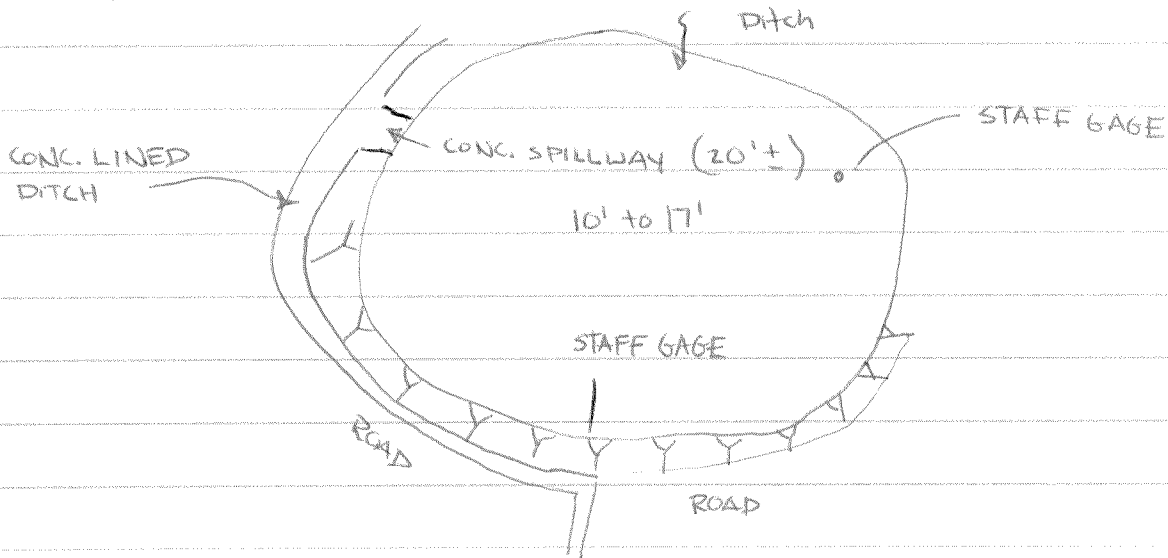
Corrective Actions:

- ☐ e. _____

Additional Comments:

On the date of this limited visual inspection, there appeared to be no immediate threat to the safety of the dam. No assurance can be made regarding the dam's condition after this date. Subsequent adverse weather and other factors may affect the dam's condition.

Reservoir is fed from the Kauhikoa ditch (controlled by wooden gate)
outlet works feeds irrigation ditch and/or drip irrigation system
concrete spillway discharges into a concrete lined ditch that runs
along the downstream slope toe. Kauhikoa

**Limitations and Intent of this Dam Safety Inspection:**

This Dam Safety Inspection was conducted to assess the general overall condition of the reservoir/dam, identify visible deficiencies, and recommend areas of for monitoring, additional investigative studies and corrective actions. The inspection is based only on visible features/areas of the dam on the day of inspection. This inspection is not a formal phase I or phase II dam safety inspection and does not include a review or evaluation from each specialist of an inspection team, such as a geologists, civil, geotechnical, structural, or hydraulics engineer. The owner should verify the findings of this report and take corrective actions. The owner may submit to the State alternative corrective actions that are certified by a licensed professional engineer in the State of Hawaii experienced in the design and construction of dams. This inspection does not relieve the owner/operator from their responsibility to conduct routine inspections, maintenance, repairs, modifications, monitoring, documentation, and/or investigative studies. The inspection was conducted under the authority of the Hawaii Revised Statutes Chapter 179D, and Hawaii Administrative Rules, Title 13, Chapter 190, titled "Dams and Reservoirs". Questions regarding this inspection should be forwarded to the Hawaii State Dam Safety Program; PO Box 373; Honolulu, Hawaii 96809; Ph. (808) 587-0236.